TIIAP FY 1999
Project Narrative

North Platte Nebraska Hospital Corp.

Grant # 31-60-99005
Health
North Platte, Nebraska

I. PROJECT DEFINITION

On Friday evening, February 19, Sally Roberts* was the victim of a rollover automobile accident in Ogallala, Nebraska. Her injuries were serious and required numerous x-rays. As soon as the x-ray films were ready, they were loaded into a car and driven to the Great Plains Regional Medical Center in North Platte, Nebraska. Luckily the weather was clear and it only took an hour for the films to reach a radiologist! The radiologist read the films and called the nurse in Ogallala. Over 1 1/2 hour after the accident, Sally Roberts' physician finally received important information necessary to proceed with her treatment. Had the accident occurred in McCook, Ord, or Lexington, Nebraska, the five or six images could have been sent via an existing teleradiology system. However, at electronic transmission speeds of 12 to 15 minutes per image, it would have taken almost as long to drive them to North Platte!

The scenario described above is not unusual in serious emergency situations in rural West Central Nebraska, Northern Kansas, and Southern South Dakota. Currently, a primary care physician must wait 1 1/2 to 3 hours in an emergency situation to receive the results of a radiology consult. In non-emergency situations, the locations use a courier service to transport images and the wait time increases to 1 to 4 days. Appendix Item 1 lists the thirteen sites included in the project, the population of the counties in which they reside, and the average wait times for radiology consults in both emergency and non-emergency situations.

As noted above, the current electronic transmission solution falls short of delivering the connectivity necessary in emergency situations. The delay in transmitting images to one of the 5 radiologists serving the area and the subsequent untimely return of radiology reports to rural physicians may result in unnecessary loss of life or other adverse patient outcomes, unnecessary treatments or procedures, needless transportation of patients far from home, and excessive length of hospital stays. The lack of timely access to radiology services clearly has a negative impact on the quality of health care for over 100,000 rural residents of the seventeen counties served by the Great Plains Regional Medical Center. This region is depicted in Appendix Item 2.

The overall goal of this project is to improve the quality of health care for rural residents by making the expertise of a radiologist available to rural primary care physicians 24 hours a day, 7 days a week, within 30 minutes of a request for a radiology consult. To fulfill this goal, we propose the development of a wide area network (WAN) using virtual private network (VPN) technology and the combination of satellite, frame relay, and ATM high speed internet connections to electronically join the thirteen locations serving the counties depicted in Appendix Item 1. While the individual encryption, authentication, and tunneling technologies that comprise VPN are not new elements of networking, their innovative combination facilitates the development of secure, cost-effective private networks that transmit data via the public Internet. Teleradiology systems with film digitizers connected to this network will close the link between radiologists and remote images via the VPN. The technical network components are illustrated in Items 4A and 4B and the teleradiology components are illustrated in Item 5 of the appendix. Both are discussed in detail in Section IV on page 4.

* Name has been changed to protect privacy of the patient.

We believe the implementation of the proposed network infrastructure will result in timely exchange of radiology and related medical information between physicians at remote locations and the radiologists in North Platte, Nebraska. This timely exchange of images and information will produce the following outcomes within and beyond the grant period which contribute to improved quality of health care for rural residents:

- Rural primary care physicians will receive more complete information on which to base their choices regarding patient care.
- Adverse patient outcomes related to a lack of timely information will be avoided.
- Unnecessary procedures and treatments performed as precautionary measures due to lack of complete information will be avoided.
- Length of hospital stays will be reduced for those patients who may not be discharged until radiology results are known.
- Needless transportation of patients to North Platte to receive more timely radiology results will be reduced.
- Satisfaction levels of patients treated in rural areas will improve.
- Satisfaction levels of rural primary care physicians with the radiology services provided by Great Plains Regional Medical Center will improve.

Projecting into the future, we anticipate that the long term impacts of improving the quality of care for rural residents through this project will be reflected in an overall improvement in the health indicators compiled by the Nebraska Office of Rural Health which profile each county.

II. EVALUATION

The proposed project evaluation process determines if the project has met the stated goal and if the expected outcomes of the project have been realized. To this end, the project evaluation process examines aspects of the quality of patient care as described in the anticipated outcomes listed in the previous section, and aspects of network performance that impact achievement of the project goal. Thus technology assessment will also be a necessary part of the project evaluation.

The evaluation plan will address the following general questions:

- What is the average time from request of a radiology consult by a rural primary care physician to receipt of the radiology report by the requesting physician?
- What technology factors affect the transmission time of medical information? How do these factors affect transmission time?
- What, if any, changes in patient care choices by rural primary care physicians are evident since the network was implemented?
- What, if any, changes have occurred in the distribution of patient outcomes among rural patients requiring radiology services since the network was implemented?
- What, if any, changes have occurred in the procedures/treatments prescribed for patients requiring radiology services since the network was implemented?
- What, if any, changes have occurred in the number and length of hospital stays for rural patients requiring radiology services?
- What, if any, changes have occurred in the transportation patterns of rural patients requiring radiology services?
- How have the satisfaction levels of rural patients with the quality of their health care changed since implementation of the network?

- How have the satisfaction levels of rural primary care physicians with radiology services changed since implementation of the network?

The evaluation strategy consists of a pre-implementation/post-implementation study model that will involve extensive field study of network sites. Data will be collected prior to implementation of the new network technology and on two separate occasions following the implementation. The comparison of the pre-/post- measures will allow the evaluators to more clearly identify those changes both directly and indirectly related to the network implementation, and determine if the project goal has been met and the anticipated project outcomes have been achieved.

The evaluators will make a minimum of four visits to each of the thirteen network sites. An initial round of visits to the thirteen network locations will be conducted prior to network implementation to conduct interviews with physicians, selected medical personnel, technical staff, and patient focus groups. The purpose of this visit is to validate proposed measures and data items. Based on the outcome of these interviews, the evaluators will establish final data items/measures, and formulate qualitative interview questions to be included in the evaluation study. Where possible, existing pre-validated measures will be incorporated. A combination of quantitative and qualitative data will be collected in subsequent visits. The second visit will collect data for baseline, pre-implementation measurements. Following implementation and full operation of the network, one visit will be conducted at three months post-implementation, and a second visit will be conducted at 9 months post-implementation. Results of both post-implementation data collections will be compared with the baseline measurements, and with each other to determine the impacts of the implementation. Qualitative data will be analyzed using protocol analysis techniques, and quantitative data will be subject to basic statistical methods.

A team of two research-trained consultants will work in tandem to conduct the evaluation process. Both consultants have Ph.D. degrees in the information systems field with prior research experience. Bonnie Buckland, former Information Services Director at Great Plains Regional Medical Center, has excellent insight and experience with the current information systems and network structure. Kathy Lassila, a faculty member at the University of Southern Colorado, has done extensive research and published studies on the impact of regional health information networks. Both Buckland and Lassila bring depth of experience in evaluating the impacts of information technology on organizations to the evaluation process. Lassila was also involved in the grant development process. The funds budgeted for the consultants are included in the budget narrative and represent approximately 3 % of the total project budget.

III. SIGNIFICANCE

Implementation and use of teleradiology systems and wide area networks alone are neither new nor innovative. In fact, several prior Telecommunications and Information Infrastructure Assistance Program grants have funded efforts that included a teleradiology component. For example, the State of North Carolina received a grant in 1994 to link hospital emergency departments and provide teleradiology consults as well as other teleconsultations during emergency situations. The project used broadband, ATM/SONET-based technology. In 1995, the Oklahoma Department of Commerce received a grant to extend the state's on-line services, including teleradiology and telemedicine to 15 rural communities. And in 1997, the Mayor's

Office of Community Services in Philadelphia, Pennsylvania received a grant to fund a community services network incorporating telemedicine.

The Great Plains Regional Medical Center (GPRMC) proposal differs from these projects, and other similar efforts, in a number ways. These differences are the keys to the significance of this project. First, rather than utilizing new technologies in support of traditional WAN infrastructures consisting of leased-line systems or frame-relay subscription services, this project employs innovative virtual private network (VPN) technology to leverage the internet as a transport medium. It also takes advantage of high-speed satellite access to the Internet in remote areas where other telecommunication services are not readily available or as cost-effective. In addition, the VPN provides several advantages over more traditional WAN infrastructures such as large cost savings, scalability, and a single, more manageable network infrastructure.

Second, this project is being proposed by a small, local, non-profit organization rather than a government office or agency. The partners involved in this program are also either small, local, non-profit organizations or individual physicians closely tied to their surrounding communities. The prior projects funded by TIIAP included the involvement of a significant government office or agency and do not have the same relevance as this proposal for small, local organizations.

Third, this project demonstrates an advanced technology that more closely meets the needs of remote, rural areas where sophisticated telecommunications technologies are not always available, and if they are their costs may be prohibitive. It shows how existing telecommunications components can be innovatively combined to solve network access and management problems.

Fourth, this project extends and enhances current teleradiology technology. The use of satellite technology is expected to enhance image transmission quality. Our primary teleradiology equipment vendor, Cemax-Icon (owned by Kodak), is excited by this prospect. The proposed virtual private network represents the first connection of its type to link with teleradiology.

Finally, this project will provide a realistic model for the multitude of other small, non-profit health care organizations confronted with similar problems of remote access to medical expertise. The use of an advanced technology that can be readily implemented and maintained for significantly less money than traditional WAN technologies, in addition to being relatively easy to manage, will potentially benefit a large number of small local organizations. In fact, this project has already drawn the attention of other small health care organizations. A letter of interest and support from Quorum Health Resources is included as Appendix Item 6.

IV. PROJECT FEASIBILITY

Developing a feasible technical solution to the problem stated in this project presents a significant challenge. Numerous inhibiting factors to telecommunications access exist. For example, several different phone companies provide service in the 13 locations that must be networked. Cost of access, availability of services, and time to install equipment and make available varying telecommunication services varies by phone service provider and location. In addition, each of the health care locations to be networked has a variety of equipment and personnel with various levels of network expertise, while some areas lack both. A solution was desired to allow multiple diverse network technologies to be efficiently and effectively

connected, be cost-effective, easy to manage, scalable, and accommodate a variety of applications.

A. Technical Approach

Virtual private network (VPN) technology was selected for the benefits it provides in the development of a WAN and its ability to meet our solution requirements. VPN provides the medium to use the public Internet backbone as an appropriate channel for private data communications. In general, the Internet VPN process begins with a client computer connecting to the Internet. Special client software recognizes a specified destination and negotiates an encrypted VPN session. The encrypted data packets are wrapped in Internet protocol (IP) packets to "tunnel" their way through the Internet from one local area network (LAN) to another. The VPN server at the receiving LAN location negotiates the VPN session and decrypts the packets. The unencrypted traffic flows normally to other servers and resources on the LAN. Thus a user at one location can seamlessly and securely access data and applications on a LAN in a remote location. It is this connection that will make teleradiology consults possible for radiologists in North Platte. Thus the first piece of the puzzle in the proposed network design is the teleradiology component which must exist at each location. Item 3 in the Appendix shows the existing and proposed imaging and teleradiology equipment at each of the 13 locations to be connected to North Platte.

The second piece of the puzzle is the direct, high-speed connection necessary for each of the 13 locations to connect to the Internet. The telecommunications services and capabilities in each of the 13 locations were explored to identify the most cost-effective option for the proposed project. Frame relay is available and optimal in four locations. For nine sites where frame relay internet access was not a viable option, a satellite connection is proposed. Frame relay T1 lines will also be used to connect North Platte to the internet, but may be replaced by ATM technology if the technology is available in North Platte at the time of implementation. Note that commercially available internet connections via local internet service providers (also not available in all locations) were not considered due to their significantly slower transmission speeds. The internet connection components at each of the 13 locations are also presented in Item 3 in the Appendix, and Items 4A and 4B show the overall network and site configurations.

The third piece of the puzzle is the VPN hardware and software necessary for authentication and encryption, and creating the “tunnel” across the internet from one LAN connection to another. All 13 locations require the VPN components, and they are also listed in Item 3.

Our selection of a technical approach clearly examined the technical alternatives, interoperability, scalability, and system maintenance. Each of these areas is discussed briefly below.

TECHNICAL ALTERNATIVES. In many rural areas access to fiber optic resources are not yet available. In addition, for smaller organizations the expenses associated with leased lines are prohibitive. Our approach for selecting a technology solution relied on effectively confronting these issues. By examining the cost and commercial availability of options in each area, we arrived at the configuration described above. Since the Internet is the VPN backbone, the VPN approach easily and cost-effectively integrates diverse Internet connection technology.

INTEROPERABILITY. Since the VPN's primary role is connecting remote LANs via the Internet, there are few interoperability issues. A radiographic image is digitized using a film digitizer, and the image is transmitted from a remote location to the radiologist's workstation where it is viewed and interpreted. Data transmission across the network is not dependent on any vendor-specific requirement. The data packets of diverse types being transmitted are wrapped in the internet protocol (IP) and tunnel their way to the appropriate location where they are unwrapped and made available to the user.

SCALABILITY. One of the key reasons for using the VPN approach is the almost unlimited potential for making clinical information and medical applications resident at the Great Plains Regional Medical Center and other sites accessible to physicians treating patients in remote locations. New applications and data can be added to networks at any of the sites and be made available in a secure mode to users across the network. In fact, we readily anticipate offering VPN access to physicians and radiologists from their homes. One potential concern is the throughput speed on the Internet. As past trends indicate, users are flocking to the Internet in record numbers. Since the VPN relies on the Internet as a backbone and transmission time is a key issue, we will be carefully monitoring these areas during the project and beyond.

MAINTAINING THE SYSTEM. Another advantage to the VPN is its ease of maintenance. As new, more cost-effective means of high speed internet access become available, the sites to which these technologies are available can easily be converted. In addition, the VPN software allows for remote management of VPN components that will allow many network aspects to be monitored centrally from the North Platte location.

B. Applicant Qualifications

The members of the project team are eminently qualified to guarantee the success of this project. Mr. Mel McNea, head of the Radiology Department at Great Plains Regional Medical Center, has championed the project from the beginning. He is familiar with both technology and organizational issues. Kim Dyer, Chief Operations Officer at Great Plains Regional Medical Center is a strong project advocate and will work in tandem with McNea. Both McNea and Dyer have prior experience implementing successful multi-million dollar technology projects in health care. Brandon Kelliher will supply network and information systems technical expertise. Kelliher has over ten years of experience in the information systems field and over four years in wide area networks. He is also chief architect of the proposed network design. Additional members of the project team will include one individual with network and information system background and a second representative from the radiology department. The qualifications of the project evaluators, Buckland and Lassila, are discussed on page 3.

C. Budget, Implementation Schedule, and Timeline

The total project cost is estimated at $1.05 million. We are requesting approximately 50% in matching funds from TIIAP. Of the total project cost, approximately 83 % ($868,450) is allocated to network equipment and teleradiology equipment. Personnel costs account for 12% of the budget and the remaining costs consist of travel, training, evaluation consultants and other related startup expenses. Budget details are discussed in the attached budget narrative. Letters of support from our partners summarizing their contributions to the project are included in the Appendix Items 8 through 21.

The implementation of the proposed project will take approximately 24 months from inception to completion of the final scheduled evaluation review. The overall implementation approach will be a staged format. Following notification of grant approval, four months of detailed planning will occur and coincide with preparations for the North Platte installation. Some of the planning decisions to be made include the order in which sites will be added to the network, the establishment of training schedules for personnel, and other detailed implementation plans. At the same time, the evaluation team will make an initial round of visits to the network sites to finalize the data items and measures to be incorporated in the evaluation study, and conduct a second visit at the North Platte location to establish baseline measurements. The second round of evaluation visits to the other sites will occur in the month prior to implementation at each site.

After detailed planning is completed, North Platte will be the first site installed since it is the network hub. Two additional sites will be added to the network each month for the next two months, followed by one site per month for the remaining eight sites. Post-installation evaluation visits to each of the sites will be conducted at 3- and 9-month intervals following installation. A summary project timeline is included in Item 7 in the Appendix.

D. Sustainability

One of the major advantages of the VPN architecture is its cost affordability. Following the startup, we anticipate that monthly costs of the network at each location will be absorbed by our partner location hospital or clinic. We presently estimate that the on-going monthly cost of the network will be between $339 and $400 for satellite transmission and frame relay connections. The monthly cost at North Platte will be considerably higher, possibly in the range of $5200 per month. Our objective is to negotiate a cost-sharing arrangement with our partners since they will all benefit from the network connection to North Platte.

V. Community Involvement

The proposed project will involve partners from the 13 communities the network will serve. Our primary partnerships are with the hospitals, clinics, and doctors who serve these communities. Their participation in the network will allow them to significantly improve the quality of patient care for their residents. An informational meeting with partners from these communities was conducted in early March to discuss the proposed project. Representatives from all of the locations attended. The proposal was met with great enthusiasm and support. We have received commitments for support from our community partners. Their letters are included in Items 8 thorugh 21 in the Appendix.

Our secondary partnerships are with the community members themselves, represented by the Chambers of Commerce. By enhancing access to much needed medical expertise, we enhance the quality of health care in the community and strengthen the Chambers' ability to attract new residents. This helps build stronger communities. Letters of support from these community representatives are included in Items 27 through 32 of the Appendix.

Our tertiary, and arguably most important partners, are the residents of the communities we are attempting to serve. As our prospective patients, they plan to benefit the most. The evaluation team will be conducting patient focus group meetings that will also serve to inform them of our proposed project.

Physicians and other medical personnel are our primary end users. Training for all involved medical personnel will be included in the installation and implementation activities. Product vendors will provide some training, and other training will be provided by project team members and appointed project agents. During and after the installation, technical support will be made available from the North Platte location via technology services.

Privacy and confidentiality are built into the network design. The tunneling mechanism of the VPN allows patient data to be encrypted and transmitted securely over the public internet. Authentication required when the network is accessed insures that unauthorized individuals will not be able to gain access to sensitive patient data. In addition, evaluators or trainers will be required to sign a confidentiality statement further protecting dissemination of sensitive partner data and materials to which they may be granted access during the course of the project.

VI. Reducing Disparities

The key disparity we hope to overcome with this project is the difference between the quality of health care afforded the more than 110,000 rural residents in the network area, and that available to urban Nebraska residents. There can be little doubt that this disparity makes a difference in the overall quality of life for a significant portion of the population.

In addition to the impact area depicted in Item 2 of the Appendix, the Cherry County Hospital in Valentine, Nebraska, is a referral center for patients from the Indian Health Service located in Rosebud, South Dakota. We also have an opportunity in this project to provide a higher standard of care for the Native American population that is referred to our area from this source. A letter of support from Indian Health Services is included in the Appendix.

In terms of disparities in access to information infrastructure technologies and services in the community, the proposed project brings information infrastructure to the rural regions of West Central Nebraska, Northern Kansas, and Southern South Dakota. Initially, the primary users will be physicians and medical personnel. The network will provide access to information infrastructures, which will even out the disparity between rural medical personnel and their urban counterparts. The infrastructure will support the development of future applications that will target rural residents and allow them access to a variety of health care information online.

VII. Documentation and Dissemination

The documentation, dissemination, and evaluation processes overlap significantly in the proposed project. Evaluators have been involved in the project since initiation of the grant proposal, and are involved continuously throughout the project as evidenced by the implementation description and timeline discussed in Section IV. Since extensive field study is employed in the evaluation process, evaluators will have on-going communication and contact with project team members, project participants, and project partners. They will be the primary "project historians", and will have access to all project memorandums, project status reports, and related information.

Project evaluation and documentation are also closely tied to information dissemination. Both evaluators have conducted and published research, and will be approaching the multi-site field

study represented by the evaluation effort as a major research project. In addition to the project evaluation, an expected outcome of their efforts is a series of conference presentations and publications in both health care and computer information systems outlets. In health care, the intended target audience includes health care and public administrators, radiology departments, health care information systems departments, and medical personnel. In the information systems arena, the intended target audience includes information systems administrators, network architects and administrators, and technology vendors. Target conferences and journals include *Health Information Management Systems Conference*, *Topics in Health Information Management Journal*, *Medical Informatics Journal, the International Conference on Information Systems*, *Management Information Systems Quarterly*, and *Journal of Management Information Systems.*